The American Fertilizer

93 JULY 20, 1940 No. 2

Published every other Saturday. Annual subscription: In the United States, $3.00; Canada and Mexico, $4.00; other countries, $5.00. Entered as second-class matter, January 15, 1910, at the Post Office at Philadelphia, Pa., under Act of March 3, 1879. Registered in United States Patent Office. Publication office, 1330 Vine St., Phila., Pa.


PHOSPHATE ROCK
CHARLESTON MINING COMPANY, Inc.
RICHMOND, VA., U.S.A.

. . . THE . . .

AMERICAN FERTILIZER

"That man is a benefactor to his race who makes two blades of grass to grow where but one grew before."

Vol. 93 JULY 20, 1940 No. 2

Some Reactions With Nitrogen Fertilizing Materials in the Soil

By JACKSON B. HESTER

Department of Agricultural Research, Campbell Soup Company, Riverton, N. J.

YEAR by year as the organic matter content of the soil becomes less, due to increased intensive cash cropping systems and decreased additions of organic matter to the soil from manure and crop debris, the question of the use of nitrogen in commercial fertilizers becomes increasingly important. While there is widespread use of many chemical nitrogen compounds in crop production, the course of the reaction of these compounds in the soil is but little appreciated. Further, conditions of the soil and climate are so varied that generalizations regarding the action of certain compounds are not always identical. During the course of the past few years a series of experiments have been carried on by the author bringing out some of the properties of certain of the common nitrogen supplying compounds under certain conditions, which perhaps will be interesting to some in the fertilizer industry.

Soil Absorbing Complex

There exists in the soil two important complexes from the standpoint of plant nutrition, clay and organic matter. While it is known that the retention of the nitrogen by organic matter and the retention of the organic matter in the soil by clay are important factors in soil fertility, but it is not too much in error to speak of the two complexes separately. These two compounds have great absorption or buffer capacity and but for their existence in the soil the present practice of using commercial fertilizers would not be possible. When a commercial fertilizer is added to the soil, the first reaction is with the absorption complex.

The clay particle may be thought of as complex aluminum or iron silicates bound together by organic matter and other chemicals afloat in molecular or bound and free water. A mental picture of a single particle may be crudely represented as shown in Fig. 1.

The clay particle or aluminum silicate is strongly acid (pH 3.5—some variations for different compositions) and consequently has a strong affinity for positive ions (calcium, magnesium, potassium, ammonium and sodium). The only way that these ions can be replaced from the silicate is by other positive ions, the most potent being hydrogen. Consequently, when soils are subjected to leaching with carbon dioxide saturated water (carbonic acid), the hydrogen enters the complex forcing the bases out and the soils become acid.

While bases (cations) have a strong affinity for the clay micelle, they have a stronger affinity for stronger acid anions like nitrate, chloride, sulphate, etc. Thus, when nitrogenous fertilizer salts are added to the soil, certain fundamental and important changes take place within the clay micelle. For convenience in explanation, it will be satisfactory to take the clay particle as calcium saturated and call it calcium clay and the first salt, ammonium sulphate.

Reaction of Ammonium Sulphate in Soil

When sulphate of ammonia is added to the soil it reacts with the clay about as follows: calcium clay + ammonium sulphate → calcium sulphate and ammonium clay. The calcium sulphate is in the outer sphere of free water and is subject to leaching or absorption by plants. In turn, soil micro-organisms attack the am-

monia and break it down into nitric acid. The nitrate radical has greater affinity for bases than the silicate radical; thus, a potassium, calcium or magnesium ion is taken away from the clay micelle and the hydrogen ion replaces it. The plant in turn absorbs the calcium, magnesium and potassium nitrate or they are leached; thus, the soil becomes more acid according to the following reaction: ammonium clay + calcium clay → hydrogen clay + calcium nitrate, or it may be said that 14 pounds of nitrogen equals 28 pounds of calcium oxide. In the course of the reaction one calcium ion is lost with the sulphate radical and one with the ammonia as the nitrate radical. Thus, sulphate of ammonia increases the acidity of the soil by increasing the activity of the soil through speeding up the normal, natural processes. Therefore, sulphate of ammonia greatly stimulates plant growth on an average soil carrying abundant calcium. However, it must not be concluded that all of the nitrogen has gone through this cycle, for on sandy soils some of the ammonia may have been leached as sulphate of ammonia and some absorbed by the plant as such. From this it is interesting to see how nitrate of soda or potash behaves in the soil.

Reaction of Nitrate of Soda

When the nitrate ion, carrying a base, is added to the soil, a similar but different reaction takes place. Calcium clay + sodium nitrate → calcium nitrate + sodium clay. Calcium nitrate is available to the plant immediately or subject to leaching as the case may be. Sodium clay is not stable and itself is subject to leaching, or what more likely happens is that as the clay moves it comes in contact with other ions and the sodium is leached as chloride or remains as sodium clay. Thus, sodium nitrate is slightly basic or neutral in the soil, depending upon plant absorption. The sodium is more readily leached from the soil than the other bases and is one reason for the salt in sea water. A salt like urea reacts even differently in the soil.

Urea

Urea first goes into solution itself carrying no distinctive charge but enzimatic action in the soil splits it into ammonia nitrogen very readily. Thus, urea + water and enzymatic action → ammonia + carbon dioxide. Water + carbon dioxide → carbonic acid. Ammonia + carbonic acid → ammonium carbonate. Ammonium carbonate + calcium clay → ammonium clay + calcium carbonate. Ammonium clay + calcium carbonate + micro-organisms → calcium nitrate + hydrogen clay. Then calcium nitrate is available to the plant or subject to leaching. Thus urea creates an acid reaction in the soil.

Cyanamid

Calcium cyanamid behaves somewhat similar to urea in the soil. Thus, calcium cyanamid + enzymatic action → calcium clay + urea. The cyanamid radical is believed to go slowly over into urea and finally through the above mentioned process to nitrate nitrogen. This accounts for the fact that it remains in the soil a much longer period before it is subject to leaching. It must remain, however, that all

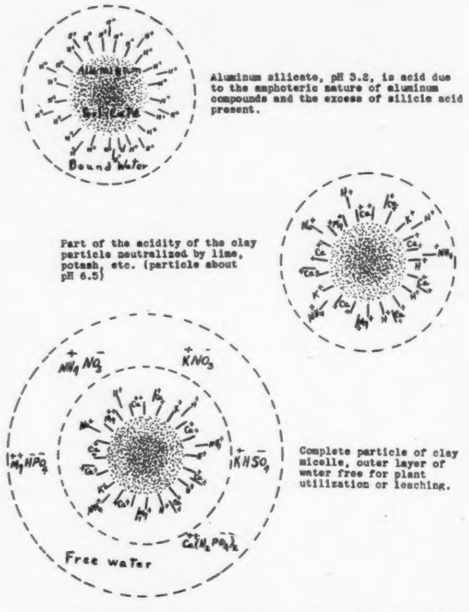


FIG. 1. Illustrating three successive stages of clay particle, showing complex nature of the plant food absorption complex.

nitrogen that is available to the plant is subject to leaching by heavy rainfall. Cyanamid produces the basic reaction because it is made up of free lime above that necessary to neutralize the acid developed by the oxidation of the nitrogen to nitrate nitrogen.

Protein Nitrogen

Protein nitrogen from cottonseed meal, blood and tankage goes through about the following reaction: protein + micro-organisms → ammonia + carbon dioxide. Ammonia + micro-organisms → nitric acid. Nitric acid + calcium clay → calcium nitrate + hydrogen clay. Consequently, these compounds are acid-forming in

the soil. From the nature of the reaction it can be seen that these undergo more changes in the soil than straight ammonia forms of nitrogen. This is the reason for slower action in the soil. Since much carbon dioxide is involved in the breakdown, this may be the reason for the reported superiority of the organic nitrogen compounds over straight mineral nitrogen compounds under some conditions.

It should be mentioned that the above reactions are not the only changes that go on in the soil. The organic materials added to the soils are forever undergoing changes. Consequently micro-organisms are constantly breaking down and building up complex organic compounds. Furthermore, in the presence of large quantities of cellulose in the soil, nitrate nitrogen may be utilized in breaking down this cellulose and not be available to the plant until it is changed back to nitrate nitrogen even later.

With the above theory as a background it may be interesting to examine some leaching data with various forms of nitrogen in the soil.

Leaching Experiments with Nitrogen Compounds

While at the Virginia Truck Experiment Station, the author planned an experiment using a Norfolk fine sand, testing approximately pH 5.6, in which equal quantities of nitrogen were used from various sources. The phosphorus and potash were added from superphosphate and muriate of potash and in equal amounts to each pot. One-half of the pots were planted to each of the following crops: sorghum, beans, kale, and rye. All of these crops were grown during a period of eleven months. None of them was grown to maturity but only until a strong vegetative growth was produced. The object of the experiment was to crop out the available nitrogen as well as any other plant food that might be absorbed by the plant. After each crop was harvested, except the bean and kale (which made rather unsatisfactory growth due to the acidity of the soil), the soil was leached with sufficient rain water to yield two liters of leachate of which chemical analyses were made.

In order to conserve space all of the data have been confined to a summary in Table I. Although the experiment was conducted upon a virgin Norfolk sand without the addition of lime, certain interesting points were brought out. The first leaching was made ten weeks after the nitrogen compounds were added to the soil, thereby providing time for some biological action to have taken place before leaching actually occurred. Owing to the fact that this soil was virgin, some of the added nitrogen was no doubt consumed in further breaking down the organic matter in the soil.

On this soil, the dried blood gave the largest yield of dry matter, followed by urea and nitrate of soda. Owing to the acidic nature of sulphate of ammonia, the lowest yield was obtained with this salt. Since this soil was so open in nature and low in clay content, much of the nitrogen leached even in the ammonia form. Under natural conditions very little nitrogen in the ammonia form leaches before it is changed to the nitrate state. The results from this experiment bring out the fact that the anion content largely controls the leaching of cations. Not as much calcium was leached from the soil to which nitrate of soda or blood had been added as when suphate of ammonia and urea were used. Furthermore, the growth of plants in certain pots in this experiment markedly altered the leaching factor. In other words, when fertilizer is applied, unless the crop absorbs the plant food, the loss from leaching is serious. Consequently, the practice of applying certain fertilizer materials as the plants

(Continued on page 24)

Table I

A Summary of Leaching Data From Pot Cultures Using Certain Nitrogen Sources

Source of Nitrogen*	Grams Total Dry Wt. Crop	Milli-equivalents					Milligrams			pH	
		NO_3	NH_4	Ca	Mg	K	Al	P	Clay	Leaching	Soil
Ammonium sulphate ...	60.3	7	38	25	6	4	27	0.05	78	4.6	5.1
	0.0	12	63	20	8	6	23	0.03	73	4.6	5.1
Sodium nitrate	70.5	37	3	3	3	1	0	0.22	2,320	7.1	6.6
	0.0	84	3	10	6	5	0	0.63	250	5.8	5.8
Urea	70.9	13	10	6	4	1	3	0.05	157	5.5	5.7
	0.0	44	39	25	9	8	15	0.01	144	4.5	4.8
Blood	90.2	2	2	4	2	1	0	0.10	414	6.3	5.5
	0.0	32	8	16	10	8	2	0.04	70	5.1	5.2
None	18.6	1	1	2	2	1	0	0.00	180	6.4	5.6
	0.0	3	1	3	3	2	0	0.00	128	6.0	5.7

* 2.5 grams of nitrogen added, 2-gallon pots filled with an equal amount of topsoil only.

July Crop Report

Crops have made a good start and better-than-average yields are indicated by July 1st conditions, the Crop Reporting Board states. Reports on July 1st crop prospects average substantially higher than on the same date last year and nearly as high as two years ago; but yields are not expected to be as high as in those years —1938 and 1939—unless the weather during the growing season after July 1st should be equally as favorable. During the first 10 days of July rainfall has been reported to be deficient in most of the area from Illinois westward, and a large part of the south reports too much rain.

With the good yields now in prospect, total crop production is expected to be fully up to the average of the pre-drought years, and only slightly below production last year. But total crop production will not be as much above average as yields per acre because of the small acreage of crops being grown. After making an allowance for late plantings, for average abandonment of cotton, and for loss of other crops, the acreage to be harvested is expected to be only about 2 per cent above the small acreage of last year and 3 per cent below the average of the last 10 years—a period that includes the great droughts of 1934 and 1936. The acreage planted for harvest appears to be the fourth smallest since 1915. Potential crop production is also lessened by the reduction in the acreage planted to cotton and corn and the substitution of hay and legume crops of lower value per acre.

While crop production has not been increasing in proportion to population, requirements and markets are changing, and stocks of some commodities are so large that supplies of major products are expected to be ample. Present indications are that the production of the various crops this year will give a well-balanced total that will permit utilization of some of the reserves on hand and add little to farm stocks, except hay.

Wheat production—estimated at 729 million bushels—will be a little below average, but with a larger than usual carryover on farms from last year there will be about the usual supply. Production of rye and beans is expected to be about average, and substantially larger-than-average crops of rice, sugar, and peanuts are in prospect. There will be about an average supply of potatoes and sweet potatoes and somewhat more than the usual per capita production of fruits and commercial vegetables.

Tobacco production will probably be 30 per cent below last year's record crop but only 5 per cent below average. Flaxseed was planted on a greatly increased acreage and shows good yield prospects. The July 1st indications point to a crop of nearly 29 million bushels—more than double average production. The acreage in soybeans has also been increased—by more than a million acres, or 14 per cent—and a large crop is probable.

Feed grain production still depends largely upon how favorable the weather is for corn, but judging from conditions on July 1st, the combined production of corn, oats, barley, and grain sorghums should be about 94 million tons, or about 3 per cent below production in 1938 and 1939. As reductions in the numbers of hogs and chickens are expected to reduce the total units of grain-consuming live-stock on the farms about 4 per cent during the current year. the prospective production of feed grains would provide the usual utilization of grain per unit without drawing on the large reserves of feed grains now on the farms.

A larger-than-average production of the major fruit and nut crops is in prospect for the 1940-41 season, though combined production is expected to be smaller than last year. Larger crops of pears, plums, and citrus fruits are expected to be more than offset by smaller production of commercial apples, peaches, grapes, cherries, prunes, apricots, walnuts and almonds. Citrus crops from the 1940 bloom developed under favorable conditions in all important areas, and it now seems likely that total production may approach the record 1938-39 crop.

Commercial vegetable crops in areas that supply markets during July show an increase of 13 per cent over last year's production. The increase is also 13 per cent over the average of the past 10 years. Marked increases are looked for in the production of cantaloups, tomatoes, and watermelons. Lima beans, beets, carrots, sweet corn, lettuce, onions, peppers, and spinach are also expected to be available in larger quantities than a year ago. But lighter supplies of cabbage, celery, cucumbers, eggplant and peas are indicated.

Northern areas that will begin harvesting vegetables in August show increased acreages of late cabbage, late cantaloups, cauliflower, cucumbers, peppers, and tomatoes. Acreages of intermediate cantaloups that will be ready for harvest the last part of July, and late onions, are reported to be smaller than last year.

The 1940 acreage of vegetable crops for canning and processing is about 20 per cent larger than in 1939 and almost 11 per cent above the average of the past 10 years.

Potatoes show nearly a 2 per cent increase and sweet potatoes an 8 per cent decrease in

acreage compared with last year, indicating about the same total acreage in the two crops. Tobacco shows a large reduction of 29 per cent from last year's large acreage—a reduction of about half a million acres. Cotton, on the other hand, shows a 1.6 per cent increase in plantings and with average abandonment, the increase at harvest time would be about half a million acres.

Crop	Total Production (in thousands) Average, 1929-38	Indicated 1939	Indicated July 1, 1940
Corn, all, bu.	2,299,342	2,619,137	2,415,998
Wheat, all, bu.	754,685	754,971	728,644
Winter, bu.	571,067	563,431	523,990
All spring, bu.	183,619	191,540	204,654
Durum, bu.	29,619	34,360	34,954
Other spring, bu.	154,000	157,180	169,700
Oats, bu.	1,024,852	937,215	1,031,622
Barley, bu.	225,486	276,298	287,377
Rye, bu.	38,095	39,249	36,848
Flaxseed, bu.	10,846	20,330	28,801
Rice, bu.	44,254	52,306	54,267
Hay, all tame, ton	69,650	75,726	85,301
Hay, wild, ton	9,298	8,800	8,862
Hay, clover and timothy,[1] ton	26,030	23,640	28,840
Hay, alfalfa, ton	24,597	27,035	30,490
Beans, dry edible, 100-lb. bag	13,086	13,962	14,111
Potatoes, bu.	366,949	364,016	371,263
Sweet potatoes, bu.	72,436	72,679	68,800
Tobacco, lb.	1,360,661	1,848,654	1,291,685
Sugarcane for sugar, ton	4,439	6,197	5,874
Sugar beets, ton	8,937	10,773	10,019
Hops, lb.	[2]34,310	[2]39,380	39,868
Peaches, total crop, bu.	[2]52,723	[2]60,822	52,436
Pears, total crop, bu.	[2]26,333	[2]31,047	31,240
Grapes,[3] ton	[2]2,220	2,526	2,422

[1] Excludes sweet clover and lespedeza.

[2] Includes some quantities not harvested.

[3] Production includes all grapes for fresh fruit, juice, wine, and raisins.

July Cotton Report

The acreage of cotton in cultivation in the United States on July 1st was estimated by the Crop Reporting Board to be 25,077,000 acres, which is 1.6 per cent more than the 24,683,000 acres in cultivation on July 1, 1939, but 28.2 per cent less than the 10-year (1929-38) average. If abandonment in 1940 is equal to the 10-year (1930-39) average percentage of abandonment, an acreage of 24,616,000 is indicated for harvest in 1940. This acreage is only slightly higher than the acreage harvested in 1939, but smaller than the cotton acreage harvested in any year since 1899 except 1938 and 1939. Total plantings are well below the Agricultural Conservation Program allotments, but some farmers whose plantings are in excess of their allotments will undoubtedly remove excess acreage.

The change from 1939 in the total cotton acreage is small for the United States as a whole, and in most of the important cotton-producing states. In Georgia, Alabama, Mississippi and Arkansas the acreage is estimated to be the same as last year. In Texas there was an increase of 1 per cent; in South Carolina and Tennessee, 2 per cent; in Louisiana, 3 per cent; and in Oklahoma, 4 per cent. An increase of 10 per cent took place in North Carolina, however, where a shift from tobacco to cotton has taken place. This shift in 1940 offsets a shift from cotton to tobacco in 1939. In New Mexico, the acreage in cultivation increased by about 14 per cent, and in California, by 4 per cent. A substantial increase of 20 per cent is shown in Arizona, largely as the result of the material increase in the acreage of long-staple, American Egyptian cotton.

The acreage of American Egyptian cotton increased from 41,000 in 1939 to 70,000 in 1940. For 1940, this includes a small acreage in New Mexico. The acreage of long-staple, Sea Island cotton increased in scattered localities throughout the Cotton Belt. The acreage in cultivation in 1940 is given at 29,800 acres, an increase of one-half over the 1939 acreage of 19,500.

No report on probable production of cotton lint will be made until August 8th.

State	Acreage in Cultivation July 1 (in thousands) Average, 1929-38	1939	1940
Missouri	399	380	395
Virginia	67	33	31
N. Carolina	1,179	754	829
S. Carolina	1,630	1,248	1,273
Georgia	2,696	1,989	1,994
Florida	112	74	73
Tennessee	950	733	748
Alabama	2,821	2,100	2,100
Mississippi	3,433	2,662	2,662
Arkansas	2,922	2,187	2,187
Louisiana	1,584	1,154	1,189
Oklahoma	3,096	1,855	1,929
Texas	13,412	8,874	8,963
New Mexico	120	96	109
Arizona	190	189	227
California	293	334	347
All other	24	21	21
United States	34,929	24,683	25,077
Sea Island[1]	...	19.5	29.8
Amer. Egyptian[1]	37	41	70
Lower Calif. (Old Mexico)[2]	96	104	125

[1] Included in State and United States totals. Sea Island grown principally in Georgia and Florida. American Egyptian grown principally in Arizona.

[2] Not included in California figures, nor in United States total.

Possible Development of the Superphosphate Industry*

By SVEN NORDENGREN and HANS LEHRECKE
Landskrona, Sweden

(Continued from the issue of July 6, 1940)

Mechanism of the Granules' Action

Franck explains the sensible increase of yield when using granulated superphosphate—an increase, under field tests, of up to 100 per cent and more of the yield which was obtained with the same amount of ordinary superphosphate—in the following way: Around every granule of superphosphate is formed a spherical zone where the water-soluble phosphoric acid reacts with compounds of the soil which fix the phosphoric acid. In the zone in question, these compounds are saturated with phosphoric acid, which enables the rest of the water-soluble phosphoric acid to move freely in this space. When a root approaches this spherical zone, it will find such a high concentration of soluble phosphoric acid that it will develop a system of thin roots around the granules, and the plant can thus easily obtain its requirement of phosphoric acid. This root system has been clearly demonstrated by photographs. Franck further found that these thin roots extend to within a distance of 2 to 3 mm. of the phosphate granules, where, it is suspected, the most suitable concentration of phosphoric acid is to be found. The phosphoric acid content of fine-ground superphosphate is more rapidly fixed in the soil, and no reserves of water-soluble phosphoric acid are left.

The second method of obviating insolubility and metamorphosis of the phosphoric acid of superphosphate within the soil, as already remarked, is to modify its chemical composition. What is possible here is to change the water-solubility partly or wholly to citrate-solubility. Citrate-soluble phosphoric acid will not revert to insoluble phosphates so rapidly, or even to the same extent, as the water-soluble, because the citrate-soluble compounds have only a small power of motion in the soil, and do not react with its iron and alumina compounds as readily as the water-soluble compounds. It is known that fertilizers containing phosphoric acid in a citrate-soluble form give good fertilizing effect, which explains why, in several European countries, as well as in the United States, superphosphate is being sold not on the basis of water-soluble phosphoric acid, but on water- and citrate-soluble "available" phosphoric acid. These products are, however, largely water-soluble.

Citrate-Soluble Phosphoric Acid

There are several phosphatic fertilizers already on the market containing phosphoric acid only in a citrate-soluble form. Among these may be mentioned dicalcium phosphate, Rhenania-phosphate, ammoniated superphosphate, as well as others, manufactured by processes of sintering or smelting. Mention should also be made of the Kotka-phosphate produced in Finland by the decomposition of phosphate rock with considerably less sulphuric acid than is normally used. As this product, apart from the mono- and di-calcium phosphate, contains a large proportion of undecomposed phosphate rock, it can only be used to advantage on such acid, humic soils as are found in Finland.

The question might be asked: Is it possible to produce a phosphatic fertilizer with its phosphoric acid in a citrate-soluble form as cheaply and simply as superphosphate is being produced? Theoretically, it would be possible to produce a dicalcium phosphate from phosphate rock with about half the quantity of sulphuric acid required for the production of ordinary superphosphate; but as far as is known, no one has yet succeeded in producing a dicalcium phosphate from phosphate rock and sulphuric acid in one process. Decomposition with about half the usual quantity of sulphuric acid results, we find, in a mixture of monocalcium phosphate and undecomposed phosphate rock, and only very small quantities of dicalcium phosphate. If the superphosphate manufacturer wishes to make a dicalcium-phosphate-containing fertilizer, he is compelled, in the first place, to make ordinary superphosphate, and then, by suitable additions, to change its

water-solubility partly or wholly to citrate-soluble phosphoric acid.

We have conducted experiments with a view to manufacturing such products by mixing superphosphate, under favorable conditions, with basic slag. The citric-acid-soluble compounds and the lime in the basic slag react with the water-soluble compounds in the superphosphate, and form the citrate-soluble phosphoric acid compound, dicalcium phosphate. Tests undertaken by the Experimental Station of the International Superphosphate Manufacturers' Association at Hamburg-Horn, and by the Central Institute for Agricultural Research at Stockholm, have already shown, during the first season, that such a product, in comparatively small granules, will give fertilizing results wholly comparable with those arising from granular superphosphate. It is probable that these products will retain their fertilizing effect longer than the granular superphosphate. Trials have been arranged to confirm what is suspected.

Instead of basic slag, it would be possible to use other material having a basic effect, such as lime, carbonate of magnesia, etc., but if such compounds are added the content of phosphoric acid of the final product will be reduced. It would be preferable to employ substances containing phosphoric acid in a citric-acid-soluble form. In this way it would be possible to increase the phosphoric acid content of the final product. Suitable substances for this purpose would be fused or sintered phosphates. These products appear to possess all the qualities required for the manufacture of "reversed super," and this is another reason why the superphosphate manufacturer should maintain an interest in the development of this group of fertilizers.

We have also found that another product well suited for this purpose can be produced if ordinary superphosphate is heated to a temperature of about 1,400° C. At this temperature the sulphuric acid radical of the calcium sulphate is separated, and citrate-soluble α-tricalcium phosphate and tetracalcium phosphate are formed.

Reduction of Free Phosphoric Acid

Recently the authors have endeavored to combine the advantages of the physical method of improving the quality of superphosphate with the chemical one. Ordinary superphosphate manufactured in "dens," or in a continuously-operating process, is granulated, and the granules, when ready, are mixed with a powdered product, containing citric-acid-soluble phosphoric acid. This product can be either basic slag or a product arising in a smelting or sintering process. A reaction takes place instantly between the monocalcium phosphate and the free phosphoric acid of the granules and the citric-acid-soluble compounds of the powder. A crust is formed on the surface of the granules with a higher percentage of citrate-soluble phosphoric acid than in the interior, where it remains water-soluble. The product possesses excellent physical properties, being dry, and noncorrosive. The free acid not only disappears from the surface, but is also considerably reduced in the interior by diffusion into the crust, where reaction of the free acid increases the P_2O_5 content of the crust.

This process affords a solution of a problem which has engaged the attention of manufacturers of superphosphate from the earliest times. It is the problem of how to reduce the free phosphoric acid in the product without essentially diminishing its water solubility. The neutral reaction on the surface of the granules gives the product better storage and drilling qualities. As to its fertilizing value it is still too early to make a definite statement, but there is every reason to believe that it will be highly effective, and that the action on the soil will be even better than when ordinary granulated superphosphate is applied. The crust of water-insoluble products will protect the reserve of water-soluble phosphoric acid in the interior of the granules from a too rapid extraction with accompanying fixation of the extracted products until the roots of the plants have grown sufficiently. Moreover, the crust contains silicic acid in a colloidal form, assimilable by the plants. This condition is known to aid the fertilizing effect of phosphoric acid.

Obviously, a product manufactured on the foregoing lines would be more expensive than ordinary superphosphate. If the granulation is effected in conjunction with a continuous superphosphate process, the costs are moderate. Moreover, the costs involved in connection with the products to be added are comparatively low. On the other hand, the increased economy due to the additional fertilizing effect of the phosphoric acid in superphosphate is tangible. It should be remembered that the greater part of the soils under cultivation in many European countries are deficient in phosphoric acid, and that their phosphoric acid requirements cannot be met by ordinary superphosphate, by reason of the fixation of phosphoric acid in

(Continued on page 22)

THE AMERICAN FERTILIZER

ESTABLISHED 1894

PUBLISHED EVERY OTHER SATURDAY BY WARE BROS. COMPANY
1330 VINE STREET, PHILADELPHIA, PA.

A MAGAZINE INTERNATIONAL IN SCOPE AND CIRCULATION DEVOTED EXCLUSIVELY TO THE COMMERCIAL FERTILIZER INDUSTRY AND ITS ALLIED INDUSTRIES

PIONEER JOURNAL OF THE FERTILIZER INDUSTRY

WARE BROS. COMPANY
PUBLISHERS

1330 VINE STREET PHILADELPHIA, PA.

A. A. WARE, EDITOR

ANNUAL SUBSCRIPTION RATES

U. S. and its possessions, also Cuba and Panama	$3.00
Canada and Mexico	4.00
Other Foreign Countries	5.00
Single Copy	.25
Back Numbers	.50

Vol. 93 JULY 20, 1940 No. 2

Principal Articles in This Issue

Billion Dollar Research Fund Suggested

Calling for a billion dollar industrial research fund to create new jobs, industries, goods and services for "tomorrow," Dr. Karl T. Compton, President of the Massachusetts Institute of Technology, has urged all companies in the United States to spend two per cent of their gross income for research.

One hundred eighty-eight companies were surveyed in June by the National Association of Manufacturers Advisory Committee on Scientific Research, of which Dr. Compton is Chairman. While the results of the inquiry revealed that ten companies spent over 10 per cent of their gross income for research, the broad average of all the companies' expenditures was 2 per cent, the figure which Dr. Compton believes would open up new vistas of enterprise for the future.

"If all the companies in the United States spent two per cent of their gross income for research," Dr. Compton reported, "the total would amount to more than a billion dollars a year—probably five times as much research as is being done now.

"In the research that has not been done, America may have missed many a nylon, neoprene, polaroid or even an automobile industry.

"The future of America depends largely upon industrial research," said Dr. Compton. "Today's frontiers are in the laboratories and machine shops of industry. Here is where the new jobs, new industries, new goods and new services of tomorrow must be created.

"Although many companies have done a research job of which America can be proud, research is still one of the least developed resources of the nation. National defense needs make it particularly urgent in the months ahead for America to lead the world in research."

Manufacturers in the aviation category were found to be among the most research-minded, judging from the budgets reported, Dr. Compton said. However, research apparently is necessary to all types of industry because the survey indicates that all major lines of production have companies appropriating high percentages of their incomes for research.

Among the top ten were two manufacturers of airplanes and airplane parts, two machinery manufacturers, a manufacturer of railway equipment, an electrical equipment company, a refiner of ores, a manufacturer of glue, a combustion and chemical engineering company, and one manufacturing chemist.

AAA Superphosphate and Lime Shipments

The Agricultural Adjustment Administration announced on July 13th that farmers ordered more than 300,000 tons of liming materials under the grant of aid program during June, bringing the total for the year to approximately 2 million tons.

The report, which includes the 31 states where the grant of aid program is in operation, shows that farmers so far this year have ordered 1,998,705 tons of lime, 140,395 tons of concentrated (45 to 48%) superphosphate and 76,914 tons of 20 per cent superphosphate.

Superphosphate Materials Furnished as Grants-of-Aid Under 1940 AAA Program (as of June 28, 1940)

Region and State	Concentrated Superphosphate (Tons)	20 per cent Superphosphate (Tons)
EAST CENTRAL		
Kentucky	51,006	36,955
Maryland	169	335
North Carolina	4,292	4,627
Tennessee	18,763	15,291
Virginia	14,559	5,508
West Virginia	9,539	1,491
Total	98,328	64,207
NORTHEAST		
Connecticut	1,338	
Maine	4,753	
Massachusetts	2,240	
New Hampshire	5,220	
Pennsylvania	770	2,178
Rhode Island	343	
Vermont	1,310	7,281
Total	15,974	9,459
NORTH CENTRAL		
Illinois	256	
Indiana	1,054	
Iowa	691	
Missouri	2,035	
Ohio	1,674	
Wisconsin	2,239	
Total	7,949	
SOUTHERN		
Alabama	1,476	2,108
Arkansas	8,554	
Georgia	187	1,140
Louisiana	89	
Mississippi	799	
Oklahoma	43	
Texas	47	
Total	11,195	3,248
WESTERN		
Oregon	3,474	
Washington	3,475	
Total	6,949	
GRAND TOTAL	140,395	76,914

Lime and superphosphate are used in carrying out approved AAA soil-building practices. The AAA furnishes these materials to farmers participating in the Agricultural Conservation Program, in place of cash conservation payments.

Soil Analysis Obligatory in Germany

Under a recent governmental decree directed to expanding the nation's agricultural production to maximum levels by rationalized application of fertilizer, all German farmers, upon request, are required to submit samples of their farm soil for analysis, to the competent soil-analysis authorities.

In general, ordinary crop farmers with a minimum of 5 hectares, and garden farmers with a minimum area of 1 hectare of cultivated soil, will be called upon to supply soil specimens. One or more samples may be required, according to the needs for testing of the particular soil, as ascertained by the authorities.

Farmers will be charged a fee of 0.50 mark for each soil test but total fees will not exceed 1.00 mark per hectare. Insufficient revenue from the fees for covering the total cost of the soil-testing program will be compensated from Government funds.

The soil tests referred to will be carried out upon a comprehensive scale throughout Germany and are expected to yield scientific data regarding the precise fertilizer requirements of agricultural lands so that commercial fertilizer will be applied in exactly required amounts. The tests will be carried out by some 70 Government agricultural experimental stations situated throughout Germany. Each experimental station at the beginning of the campaign will conduct some 25,000 soil tests annually, and the number of tests will be increased to 100,000 per station annually later on when the testing campaign becomes well established.

For conducting the soil tests, advanced methods have been developed based upon the use of photoelectric cells and principles of spectral analysis. By means of this advanced physical method, the tests can be conducted rapidly and inexpensively by ordinary workers, dispensing with the former need for tedious methods of chemical analysis by scientifically trained personnel. — American Consulate General, Frankford-on-Main.

June Tag Sales

Fertilizer tonnage in 17 states in the 12 months from July, 1939, through June, 1940, as indicated by the sale of tax tags, amounted to 5,494,000 tons. This represented an increase of 2 per cent over the preceding year but it was 6 per cent below 1936-1937, which marked the peak in the recovery period. With that exception, sales in the year just closed were the largest for any year since 1930.

Total fertilizer consumption in the entire country was probably around 7,700,000 tons in the year ended June, 1940. This is based on the assumption that sales in the other states fluctuated in about the same way last year as they did in the tag sale states.

All of the states in the southern group reported increases in 1939-1940 except Virginia, North Carolina, and Oklahoma. The largest percentage gains were in Mississippi, Arkansas, Louisiana, and Texas. In these four states, and also in Florida, sales were larger than in 1936-1937. Sales in the midwest were moderately larger, with four of the five states showing increases over the preceding year.

June sales in both areas were considerably above June, 1939, with increases over last year reported by 14 of the 17 states.

FERTILIZER TAX TAG SALES

Compiled by The National Fertilizer Association

	June				July-June			
	1940				1939-40			
State	Per Cent of 1939	Tons	1939 Tons	1938 Tons	Per Cent of 1939	Tons	1938-39 Tons	1937-38 Tons
Virginia	83	9,289	11,252	8,568	95	396,772	418,982	406,419
N. Carolina	133	32,852	24,639	26,023	90	1,084,721	1,207,654	1,120,300
S. Carolina	115	16,250	14,179	19,858	101	678,449	672,753	666,746
Georgia	236	14,210	6,024	12,452	100	736,836	736,179	720,963
Florida	152	28,200	18,581	28,645	106	582,667	547,686	549,965
Alabama	101	7,050	7,010	9,650	104	576,350	552,600	533,060
Mississippi	...	9,675	733	8,250	118	345,010	293,478	301,180
Tennessee	251	2,940	1,170	280	102	136,012	133,911	134,472
Arkansas	39	300	772	250	145	102,600	70,822	64,600
Louisiana	84	1,350	1,600	1,900	113	169,673	150,046	147,518
Texas	159	325	205	360	126	116,758	92,738	87,401
Oklahoma	107	16	15	125	91	6,872	7,533	8,405
Total South	142	122,457	86,180	116,361	101	4,932,720	4,884,382	4,741,029
Indiana	...	18,300	656	469	113	299,213	265,053	266,834
Illinois	...	37	0	0	117	50,079	42,648	43,111
Kentucky	129	9,021	6,975	188	111	123,715	111,201	120,504
Missouri	...	20	2	32	110	73,044	66,421	75,781
Kansas	...	55	0	23	98	15,624	15,992	16,894
Total Midwest	359	27,433	7,633	712	112	561,675	501,315	523,124
Grand Total	160	149,890	93,813	117,073	102	5,494,395	5,385,697	5,264,153

FERTILIZER MATERIALS MARKET

NEW YORK

Orders for Basic Materials Being Placed in Satisfactory Volume. Sulphate of Ammonia Somewhat Scarce. Fishing Season Below Normal to Date.

Exclusive Correspondence to "The American Fertilizer."

NEW YORK, July 16, 1940.

Fertilizer manufacturers have been busy placing their orders for basic materials such as muriate of potash and sulphate of ammonia. Both of the above items have been in good demand but buyers are finding it difficult to obtain confirmation on their desired purchases of sulphate of ammonia, especially for deliveries to most southern points.

With the continuous increase in steel production, it appears that there should be ample sulphate of ammonia for domestic fertilizer needs. Considerable business has been booked for export for shipment through the next months, but at the moment the inquiry for export sulphate of ammonia has died down considerably.

Nitrogenous Material

After booking of considerable tonnage for the new season, this market is extremely quiet and prices firm.

Potash

Spot movement of this material is naturally quiet at this time of the year, but bookings are reported to have been very satisfactory and buyers are busy allocating tonnage for their deliveries against purchases.

Superphosphate

The market is unchanged at $8.50 per ton for run-of-pile with every indication that this market will remain firm.

Dried Blood

Domestic material is offered at $2.25 ($2.73½ per unit N), New York, with South American nominally quoted for August shipment at $2.35 ($2.85½ per unit N).

Fish Scrap

There are no offerings in the market of Japanese fish meal at the moment. Fishing in Chesapeake Bay has been very slow and therefore there is naturally a scarcity of available fish. Menhaden meal is nominally quoted at $50.00 per ton, f.o.b. Baltimore.

BALTIMORE

Between-Seasons Lull Evident. Fall Requirements Covered. Scarcity of Sulphate of Ammonia Expected.

Exclusive Correspondence to "The American Fertilizer."

BALTIMORE, July 16, 1940.

The between-season lull in the fertilizer industry is now on and there will probably be very little activity after September 1st. In the meantime, many of the manufacturers have covered for their fall requirements of materials, but the tonnage of mixed goods for the fall is small compared with the spring.

Ammoniates.—South American ammoniates still continue to rule easy, although the market on feeding materials firmed up somewhat during the past two weeks. South American tankage is still obtainable at around $2.75 per unit of nitrogen and 10 cents per unit of B.P.L., and ground dried blood is being quoted on the same basis.

Nitrogenous Material.—Interest is at a minimum, with the result that the market is strictly nominal and ranges from $2.55 to $2.65 per unit of nitrogen.

Sulphate of Ammonia.—While considerable business has already been booked, first hands are reluctant to take on any tonnage in excess of last year's deliveries, and some of the manufacturers have, therefore, been unable to cover for their full requirements. In fact, some of the buyers are anticipating a scarcity, particularly if the Government requisitions any appreciable quantity for munition purposes in connection with the national defense program. The market, therefore, is strictly nominal at $28.00 per ton, in bulk, f.o.b. port for July/December, with an increase of $1.00 per ton for January/June deliveries, although there is no tonnage to be had on this basis.

Nitrate of Soda.—Up to the present time importers have not named any prices for delivery in bags beyond July, but by the end of the month further announcement is expected cover-

ing deliveries over more extended period. The market remains unchanged, in bulk, and any increase in price will only be to the extent of the higher cost of burlap bags as compared with last year's cost.

Fish Scrap.—The price at which menhaden fish last sold is comparatively high with other feeding materials, for which reason not much interest is being shown. Last sales were on the basis of $4.25 per unit of nitrogen and 10 cents per unit of B.P.L., f.o.b. fish factories.

Superphosphate.—While there has not been any changes in the situation, some business has been booked at $8.00 per ton of 2,000 lb., basis 16 per cent for run-of-pile, and $8.50 per ton for flat 16 per cent grade, both in bulk, f.o.b. seller's works, Baltimore. This situation may be only temporary in view of the higher cost of production due to increased freight and other charges.

Bone Meal.—The market continues quiet and domestic 3 and 50 per cent steamed bone meal is quoted at $32.00 to $34.00 per ton according to mechanical condition, while 4½ and 50 per cent raw bone meal ranges from $31.00 to $31.50 per ton, c.i.f. Baltimore.

Potash.—Outside of sulphate of potash, other grades seem to be in plentiful supply. With stocks of imported potash carried over in warehouses and production of domestic manufacturers, it is anticipated there will be ample to go around for buyers' normal requirements. The market on muriate continues unchanged at 53½ cents per unit of K_2O, ex vessel ports, in bulk, subject to usual discount for early buying.

Bags.—The burlap market during the past two weeks has again been up and down, although the present price of plain, new, 10-oz. basis 40 cut 54 in., is again down to $111.00 per thousand, delivered Baltimore for fall and spring shipment.

ATLANTA

Heavy Bookings of Sulphate of Ammonia Exhausts Present Production Rate. Prices on Organic Materials Attractive.

Exclusive Correspondence to "The American Fertilizer."

ATLANTA, July 15, 1940.

Heavy bookings of sulphate of ammonia have resulted in contracts already having been made for the bulk of the estimated domestic production for the ensuing season. Quite a number of the producers have withdrawn from the market pending further developments. The trade as a whole, however, have fairly well covered their requirements and with the increased steel production, there is no actual shortage in sight as far as the domestic demand is concerned.

The export situation is quite another problem, however, since Europe is cut off and quite a large part of the world will very probably be looking to this country for supplies.

This not only applies to sulphate of ammonia but many other essential fertilizer ingredients as well. Organic ammoniates are still easy and offer a very attractive basis for purchase, as well as many of the commodities that make up this list, since prices on the average are lower than they were before war was declared last September.

The current market is as follows:

Dried Blood.—Imported, $2.50 ($3.04 per unit N), c.i.f.

Tankage.—$2.60 ($3.16 per unit N) and 10 cents.

Fish Scrap.—Menhaden catch so far has been only about 25 per cent of last years production. Unless this situation improves materially, there will be a shortage in domestic fish.

Nitrate of Soda.—Unchanged.

Sulphate of Ammonia.—Heavy bookings at producers schedule of prices.

Cottonseed Meal.—Prime 8 per cent, $21.50, Memphis, fall and winter.

Steam Bone Meal.—3 and 50 per cent, $31.00.

Raw Bone Meal.—4½ and 45 per cent, $31.50, c.i.f. the ports.

TENNESSEE PHOSPHATE

Crops in Good Condition. New Large Phosphorus Furnace Planned by Monsanto. Phosphate Shipments in Summer Lull.

Exclusive Correspondence to "The American Fertilizer."

COLUMBIA, TENN., July 15, 1940.

The first half of July in the phosphate area has witnessed the coldest weather on record for that month and for at least one week the largest amount of rainfall, well distributed. About half the wheat was threshed when the rains set in, with splendid yields and fine quality, but much of that remaining in the field has begun to sprout and quality is inferior.

Corn and tobacco crops are in magnificent shape and the pastures are luxuriant again, giving the countryside a most attractive appearance, while alfalfa and lespedeza crops are in splendid shape.

Work on the Monsanto Co.'s fourth furnace, reported to be equal in capacity to the three now in operation, is still mostly in the planning stage but construction will soon begin, with operation anticipated in 1941. Of course, this expansion has no connection with war materials, as phosphorus enters less than almost any other chemical in actual munitions. This is merely one of the many industrial expansions which private enterprise can be expected to bring about very rapidly to the extent that it is operated by men of vision, unhampered by restrictions of various kinds.

The close and keen interest which industry everywhere has in the life of communities in which they are located is, of course, axiomatic, and aside from any altruistic motives, is intensely practical and matter of fact. The communities depend on the industries for payrolls and means of livelihood, while the industries are all the more dependent on the communities for a good place for their personnel to live, as their force of loyal, intelligent and hard-working employees is the greatest asset of any industrial organization.

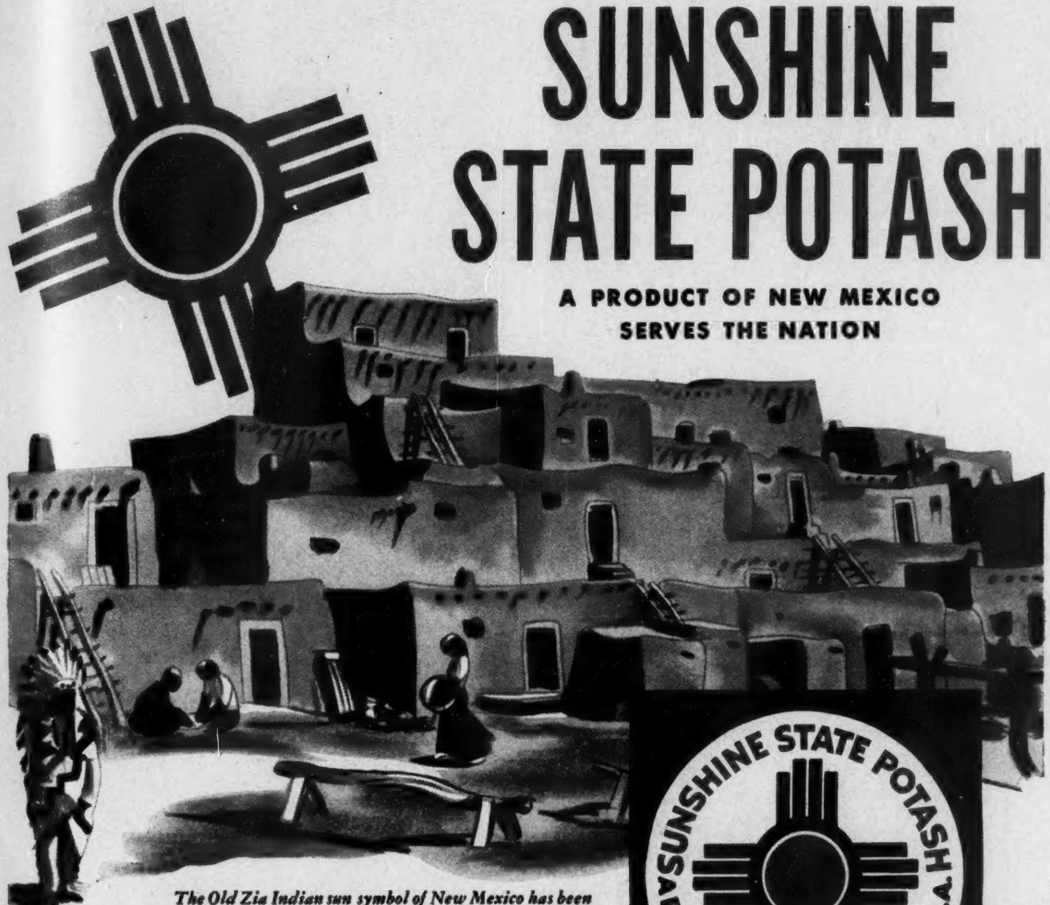
One very agreeable evidence of this interest in community life on the part of the phosphate industry has just been given here. The funds subscribed by the phosphate companies for the entertainment of the S. E. Section of the American Institute of Mining and Metallurgical Engineers on occasion of their recent meeting in Columbia and Mt. Pleasant, resulted in a substantial surplus in the hands of the entertainment committee. By the unanimous vote of the subscribers, eighty dollars was donated to the boy scouts of Maury County, so divided as to complete the boy scout library at Mt. Pleasant, and to finish paying for the splendid meeting place for boy scouts of Maury County in Columbia.

It has been ascertained that the total shipment of ground phosphate rock from the Tennessee field in 1939 was 155,000 tons, or about one sixth of total production of 930,000 tons, but a large amount of this went to manufacturers and to TVA and efforts are being made to ascertain this amount, in order to get the figures of exact amount used for direct application to soil.

Actual shipments into all consuming channels are still in the usual midsummer lull, but movement to the acidulators for the fall trade is already beginning. Movement of ground rock to farmers begins in the last half of July and the two heaviest months are always August and September.

SUNSHINE STATE POTASH

A PRODUCT OF NEW MEXICO SERVES THE NATION



The Old Zia Indian sun symbol of New Mexico has been adopted as the trademark of the United States Potash Company. This interesting symbol serves to emphasize the Indian background of New Mexico's history.

SUNSHINE STATE POTASH
A PRODUCT OF NEW MEXICO U.S.A.

Trademark Reg. U. S. Pat. Off.

GOOD fertilizer is just as essential to a good crop as rain and sunshine. Plenty of the right fertilizer—containing along with other essential plant foods, the proper potash content—makes for higher yields per acre and better quality.

Every year, thousands of tons of Sunshine State Potash go to enrich the soil in all sections of the country. The year 1940 finds Sunshine State Potash highly regarded by all fertilizer producers. They recognize the consistently uniform analysis of its Muriate of Potash and Manure Salts, and the careful sizing that makes handling and blending easy.

HIGRADE MURIATE OF POTASH

62/63% K_2O

ALSO 50% K_2O GRADE

•

MANURE SALTS

APPROXIMATELY 30% K_2O

UNITED STATES POTASH COMPANY, Incorporated, 30 Rockefeller Plaza, New York, N. Y.

CHICAGO

Prices on Fertilizer Organics Being Maintained with Inquiry Light. Feed Prices Advance.

Exclusive Correspondence to "The American Fertilizer."

CHICAGO, July 15, 1940.

Few changes in organics have developed, and prices are fairly well maintained. Inquiry is light, but this is usual at this period. The bids which have been in the market were below sellers' views, and were indignantly declined. Producers think, possibly wishfully, the bottom has been reached, and that an improved market will shortly occur.

Prices of finished feed were recently advanced and sales of materials were at corresponding higher prices.

Nominal prices are as follows: high grade ground fertilizer tankage, $2.00 to $2.25 ($2.43 to $2.73½ per unit N) and 10 cents; standard grades crushed feeding tankage, $2.30 to $2.50 ($2.79½ to $3.04 per unit N) and 10 cents; blood, $2.25 to $2.35 ($2.73½ to $2.85½ per unit N); dry rendered tankage, 52 to 57 cents per unit of protein, Chicago basis.

FERTILIZER INDUSTRY IMPROVES SAFETY RECORD IN 1939

According to the report of the National Safety Council, the 1939 injury rates for the chemical industry averaged 7.48 for frequency and 1.26 for severity, as compared with 11.83 and 1.42 respectively for all industries.

Of the 16 branches into which the chemical industry is subdivided, the fertilizer manufacturing industry showed an improvement over the previous year, decreasing its "frequency" rating by 32 per cent and its "severity" rating by 39 per cent. There is still room for great improvement, however, as the fertilizer industry stands 14th in the list as to frequency, with a rating of 16.07, and 15th in severity with a rating of 3.19. In the other branches of the chemical field, frequency runs from 0.71 to 18.40, and severity from 0.003 to 5.39.

Listed in the honor roll for 1939 are the fertilizer division of the Tennessee Valley Authority with the lowest frequency rate among large units, 7.43; the Baugh Chemical Company with the lowest severity rate among large units, 0.12; and the New Westminster, B. C. Plant of Canadian Industries, Inc., which worked 102,000 man hours without a disabling injury.

See Page 4

POSSIBLE DEVELOPMENT OF THE SUPERPHOSPHATE INDUSTRY

(Continued from page 11)

the soil. Consequently, the employment of ordinary superphosphate does not pay. If the quality of superphosphate and the method of applying it to the soil are improved, the fertilizing effect will, no doubt, be increased, and it will be an advantage to use phosphatic fertilizers on many soils where hitherto their employment had been uneconomic.

As there is a deficiency in phosphoric acid in the majority of agricultural soils, even if normal quantities of phosphatic fertilizers are applied, improvement of their fertilizing value will result in a better utilization of all the other constituents of vegetation in the soil, according to Liebig's "law of deficiency,"[17] and Mitscherlich's "law of the efficiency of the components of vegetation."[18] Hence any increase of the fertilizing value of superphosphate would be of paramount importance to agriculture throughout the world.

It is hoped that this contribution affords an indication of the probable direction in which the superphosphate industry will develop during the next few years. That there should be more intimate cooperation and collaboration between manufacturers and agricultural chemists, experimental stations and farmers, is evident, and we wish to give renewed emphasis to this view. The ideas of the customer should be sought, and an endeavor made to meet his requirements, however vaguely or indefinitely these may be expressed. Only in this way can a favorable development of the superphosphate industry be expected. The manufacture of superphosphate was first conceived by the greatest agricultural chemist of his time, Justus von Liebig, and it is felt that the superphosphate manufacturer, having concentrated his interest during the last hundred years mainly on the economic, mechanical and chemical aspects of the process of manufacture, should now devote some attention to the insistent task of agricultural research.

[17] J. v. Liebig, Chem. Briefe 1865, p. 508.

[18] Mitscherlich, Bodenkunde 1920, p. 5.

GROSS FARM INCOME EXCEEDED 9.7 BILLION DOLLARS IN 1939

Farmers in 1939 had a gross farm income of $9,769,000,000 from farm production and Government payments, it was reported lately by the Bureau of Agricultural Economics. The estimate includes cash income from marketings, Government payments under conservation programs, and the value of farm products (at farm prices) retained for consumption on the farms.

The 1939 total of $9,769,000,000 compares with $9,362,000,000 in 1938. Total for 1937 was $10,569,000,000, and for 1936 the total was $9,915,000,000.

The 1939 gross income consisted of $7,733,000,000 cash from farm marketings, Government payments totaling $807,000,000, and products retained for farm consumption valued at $1,229,000,000. In 1938 the cash income from marketings was $7,590,000,000, Government payments totaled $482,000,000, and the value of products retained for farm consumption was $1,290,000,000.

The Bureau reported gross farm income from all crops in 1939 at $3,662,000,000. This compared with $3,541,000,000 in 1938, with $4,355,000,000 in 1937, and with $4,021,000,000 in 1936. The increase in 1939 over 1938 was 3 per cent. In 1939, increases in income from grains, vegetables, fruits, and miscellaneous crops more than offset declines in income from cotton, tobacco, and sugar crops.

Gross farm income from livestock and livestock products totaled $5,300,000,000 in 1939. This compares with $5,339,000,000 in 1938,

with $5,847,000,000 in 1937, and with $5,606,000,000 in 1936. The decrease in 1939 under 1938 was 1 per cent. Declines in income from hogs, chickens and eggs, and dairy products more than offset increases in income from cattle and calves, sheep and lambs, wool, turkeys, and miscellaneous products.

Government payments totaled $807,000,000 in 1939, compared with $482,000,000 in 1938, with $367,000,000 in 1937, and with $287,000,000 in 1936. Gross farm income—including Government payments—in 1939 was higher than in 1938 in 40 states, with largest increases in the Northern Great Plains area. The 8 states where income was smaller than in 1938 were Kentucky, Tennessee, Alabama, Mississippi, Wisconsin, Georgia, Utah, and Virginia.

REDEMPTION OF CORN LOANS

The U. S. Department of Agriculture has announced that between July 5 and October 1, 1940, farmers may redeem loans on 1937 and 1938 corn stored on the farm, at a price of 58 cents per bushel. This will enable the older corn to be used for feeding live stock and will retain in storage the crop produced more recently.

SOME REACTIONS WITH NITROGEN FERTILIZING MATERIALS IN THE SOIL

(Continued from page 7)

grow, under some conditions, gains support from these studies.

The leaching of soluble aluminum was prevalent where the acid-forming salts occurred. This has been reported as one of the reasons for the lack of plant growth resulting from the use of these salts in the fertilizer mixture under some conditions.

There has been a contention that continued use of nitrate of soda tends to increase the availability of phosphorus. These studies would tend to support this conclusion although the quantity of phosphorus leached was exceedingly small. The fact that nitrate of soda tends to disperse the clay in the soil is also supported, particularly where the plants were growing. In other words, all of the nitrogen sources have a place in crop production but an understanding of the action of the compounds in the soil and how best to use them is important. When sulphate of ammonia or urea is used on an acid soil, sufficient lime to neutralize the acidity developed by these compounds is advisable. When nitrate of soda is used, cognizance should be taken of the fact that it is readily available and subject to leaching on sandy soil. When cyanamid is used, recognition must be made of the fact that a period of time should be allowed before planting on account of the possibility of injury to vegetation and for the nitrogen to have a chance to undergo some necessary changes in the soil.

Nitrogen Compounds in Growing Tomatoes

While no one particular source of nitrogen is recommended in growing tomatoes, a great deal of interest has been shown in some nitrogen studies. Consequently, a series of experiments were laid out in the field to ascertain in-

Table II

*The Influence of Nitrogen Compounds Upon the Yield and Quality of Tomatoes**

					Grams per Liter				M.E.** per Liter				
Source	Yield in Tons per Acre	% Pulp	pH of Pulp	Color and Flavor	Total Solids	Sugar	Insoluble Solids	Ascorbic Acid† Mg. per L.	Titratable Acidity	Ca	Mg	K	N
Combined nitrogen ...	11.20	98.5	4.35	B	63.45	37.05	5.98	238.5	60.0	2.5	1.8	61.7	120.2
Calnitro	10.20	88.5	4.35	B†	64.55	39.05	6.08	246.0	58.5	2.6	1.9	55.3	116.8
Cyanamid	9.69	86.5	4.3	B	63.75	36.90	5.40	248.5	63.0	2.5	2.3	54.7	112.9
Nitrate of soda	11.20	86.0	4.3	A	62.75	37.05	5.53	243.0	59.5	2.3	1.8	53.7	122.2
Ammonium sulphate ..	10.78	88.5	4.35	A	65.10	39.50	5.63	265.5	56.5	3.1	1.8	56.8	104.8
Tankage	8.99	88.5	4.35	B	63.65	38.35	5.35	258.5	58.5	2.5	2.0	57.3	109.0
Urea	11.33	89.5	4.35	B†	65.50	38.80	5.32	248.5	59.5	2.3	2.0	64.5	119.0
Average	10.48			B†	64.68	38.10	5.61	249.8	60.8	2.5	1.9	57.7	115.0

* Average for 1938 and 1939. † Vitamin C. ** Milligram equivalents.

formation about certain sources of nitrogen and their combinations in a mixed fertilizer.

A Sassafras sandy loam, pH 5.45, was limed with 1,500 pounds of hydrated lime and divided into a series of plats containing 34 plants each. Using ammonium sulphate, nitrate of soda, cyanamid, calnitro, urea or tankage and a combination of all of these as a source of nitrogen, 4-16-4 mixtures were made. These were applied in the row at the rate of 750 pounds per acre. Later, 750 pounds of 4-0-8 mixtures were applied by sidedressing, these being made from each of the same sources of nitrogen as previously mentioned. These experiments were conducted upon the same area for two successive years, 1938 and 1939, the results from which are shown in Table II.

Attention should be called to the fact that it is not probable that a commercial 4-16-4 mixture would be made by using only one source of nitrogen. Also these studies were in no way designed to recommend or encourage the use of any particular source of nitrogen in fertilizer mixtures.

From the yield records, the nitrate of soda produced a slightly larger yield in 1938, an extremely wet season, but not significantly better than any of the other sources of nitrogen except tankage and cyanamid. From a practical standpoint cyanamid was not used by the method that would allow optimum yields from it, but neither would animal tankage be recommended as the total source of nitrogen. In 1939, an extremely dry season, the combination of each source of nitrogen on an equal basis produced slightly the best yield. Again, this source was not significantly better than any other source of nitrogen except tankage and calnitro.

Dr. E. F. Kohman, of the Campbell Soup Company, made the quality analyses of fruit taken from these plats. The percentage of pulp was determined by taking 25 pounds of fruit from each plat and passing it through a small cyclone in which the skins, seeds and fibrous material were separated from the pulp. The remaining analyses were made upon this pulp which was canned, being processed just long enough to prevent decay or fermentation. It it not believed that there is anything particularly outstanding about the data; however, there are some interesting correlations which bear out the influence of various nitrogen compounds on the quality of the fruit. The prime importance in nitrogen fertilization is to use good judgment in fertilization to produce the maximum yield possible.

Perhaps the condition of the soil when the nitrogen is added is of as much importance as the source of nitrogen. Thus, the rate of availability of a nitrogen compound added to the soil can be largely controlled by the type of organic debris that is turned into the soil. Furthermore, it is of more importance to use good judgment in choosing the nitrogen compound to be used on sandy soils than that to be used on heavy soils. Indeed, it is questionable whether the leaching of nitrogen is of tremendous importance during the growing season on heavy soils. It is perhaps of more importance to have the soil well-cultivated and well-limed so that the desirable micro-organisms for crop growth can function properly.

BUYERS' GUIDE

A CLASSIFIED INDEX TO ALL THE ADVERTISERS IN "THE AMERICAN FERTILIZER"

This list contains representative concerns in the Commercial Fertilizer Industry, Including fertilizer manufacturers, machinery and equipment manufacturers, dealers in and manufacturers of commercial fertilizer materials and supplies, brokers, chemists, etc.
For Alphabetical List of Advertisers, see page 33.

A Classified Index to Advertisers in "The American Fertilizer"

BUYERS' GUIDE

For an Alphabetical List of all the Advertisers, see page 33

BUCKETS—For Hoists, Cranes, etc., Clam Shell, Orange Peel, Drag line, Special; Electrically Operated and Multi Power
- Hayward Company, The, New York City.
- Link-Belt Company, Philadelphia, Chicago.

BURNERS—Sulphur
- Chemical Construction Corp., New York City.

BURNERS—Oil
- Monarch Mfg. Works, Inc., Philadelphia, Pa.
- Sackett & Sons Co., The A. J., Baltimore, Md.

CABLEWAYS
- Hayward Company, The, New York City.

CALCIUM-NITRATE
- Synthetic Nitrogen Products Co., New York City.

CAL-NITRO
- Synthetic Nitrogen Products Co., New York City.

CARBONATE OF AMMONIA
- American Agricultural Chemical Co., New York City.
- Du Pont de Nemours & Co., E. I., Wilmington, Del.

CARS—For Moving Materials
- Link-Belt Company, Philadelphia, Chicago.
- Sackett & Sons Co., The A. J., Baltimore, Md.
- Stedman's Foundry and Mach. Works, Aurora, Ind.

CARTS—Fertilizer, Standard and Roller Bearing
- Atlanta Utility Works, East Point, Ga.
- Sackett & Sons Co., The A. J., Baltimore, Md.

CASTINGS—Acid Resisting
- Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

CASTINGS—Iron and Steel
- Jeffrey Manufacturing Co., The, Columbus, Ohio.
- Link-Belt Company, Philadelphia, Chicago.
- Sackett & Sons Co., The A. J., Baltimore, Md.
- Stedman's Foundry and Mach. Works, Aurora, Ind.

CEMENT—Acid-Proof
- Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
- Chemical Construction Corp., New York City.

CHAIN DRIVES—Silent
- Link-Belt Company, Philadelphia, Chicago.
- Sackett & Sons Co., The A. J., Baltimore, Md.
- Stedman's Foundry and Mach. Works, Aurora, Ind.

CHAINS AND SPROCKETS
- Jeffrey Manufacturing Co., The, Columbus, Ohio.
- Link-Belt Company, Philadelphia, Chicago.
- Sackett & Sons Co., The A. J., Baltimore, Md.
- Stedman's Foundry and Mach. Works, Aurora, Ind.

CHAMBERS—Acid
- Chemical Construction Corp., New York City.
- Fairlie, Andrew M., Atlanta, Ga.

CHEMICAL APPARATUS
- Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
- Monarch Mfg. Works, Inc., Philadelphia, Pa.

CHEMICALS
- American Agricultural Chemical Co., New York City.
- American Cyanamid Co., New York City.
- Armour Fertilizer Works, Atlanta, Ga.
- Ashcraft-Wilkinson Co., Atlanta, Ga.
- Baker & Bro., H. J., New York City.
- Barrett Company, The, New York City.

CHEMICALS—Continued
- Bradley & Baker, New York City.
- Du Pont de Nemours & Co., E. I., Wilmington, Del.
- Huber & Company, New York City.
- Wellmann, William E., Baltimore, Md.

CHEMICAL PLANT CONSTRUCTION
- Atlanta Utility Works, East Point, Ga.
- Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
- Chemical Construction Corp., New York City.
- Fairlie, Andrew M., Atlanta, Ga.
- Sackett & Sons Co., The A. J., Baltimore, Md.
- Stedman's Foundry and Mach. Works, Aurora, Ind.

CHEMISTS AND ASSAYERS
- Gascoyne & Co., Baltimore, Md.
- Stillwell & Gladding, New York City.
- Wiley & Company, Baltimore, Md.

CLUTCHES
- Jeffrey Manufacturing Co., The, Columbus, Ohio.
- Link-Belt Company, Philadelphia, Chicago.
- Sackett & Sons Co., The A. J., Baltimore, Md.
- Stedman's Foundry and Mach. Works, Aurora, Ind.

CONCENTRATORS—Sulphuric Acid
- Chemical Construction Corp., New York City.
- Fairlie, Andrew M., Atlanta, Ga.

CONDITIONERS AND FILLERS
- American Limestone Co., Knoxville, Tenn.

CONTACT ACID PLANTS
- Chemical Construction Corp., New York City.

COPPER SULPHATE
- Tennessee Corporation, Atlanta, Ga.

COTTONSEED PRODUCTS
- Ashcraft-Wilkinson Co., Atlanta, Ga.
- Baker & Bro., H. J., New York City.
- Bradley & Baker, New York City.
- Huber & Company, New York City.
- Jett, Joseph C., Norfolk, Va.
- Schmaltz, Jos. H., Chicago, Ill.
- Taylor, Henry L., Wilmington, N. C.
- Wellmann, William E., Baltimore, Md.

CRANES AND DERRICKS
- Hayward Company, The, New York City.
- Link-Belt Company, Philadelphia, Chicago.
- Link-Belt Speeder Corp., Chicago, Ill. and Cedar Rapids, Iowa.
- Sackett & Sons Co., The A. J., Baltimore, Md.

CYANAMID
- American Agricultural Chemical Co., New York City.
- American Cyanamid Co., New York City.
- Ashcraft-Wilkinson Co., Atlanta, Ga.
- Baker & Bro., H. J., New York City.
- Bradley & Baker, New York City.
- Jett, Joseph C., Norfolk, Va.
- Taylor, Henry L., Wilmington, N. C.
- Wellmann, William E., Baltimore, Md.

DENS—Superphosphate
- Chemical Construction Corp., New York City.
- Stedman's Foundry and Mach. Works, Aurora, Ind.

A Classified Index to Advertisers in "The American Fertilizer"

BUYERS' GUIDE

For an Alphabetical List of all the Advertisers, see page 38

A Classified Index to Advertisers in "The American Fertilizer"

BUYERS' GUIDE

For an Alphabetical List of all the Advertisers, see page 33

MACHINERY—Grinding and Pulverizing
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Power Transmission
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Pumping
Atlanta Utility Works, East Point, Ga.

MACHINERY—Tankage and Fish Scrap
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MAGNESIA
California Chemical Co., New York City.

MAGNETS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MANGANESE SULPHATE AND CARBONATE
Tennessee Corporation, Atlanta, Ga.

MANGANESE SULPHATE
Tennessee Corportion, Atlanta, Ga.

MIXERS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

NITRATE OF SODA
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Company, The, New York City.
Bradley & Baker, New York City.
Chilean Nitrate Sales Corp., New York City.
Huber & Company, New York City.
International Agricultural Corp., New York City.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

NITRATE OVENS AND APPARATUS
Chemical Construction Corp., New York City.

NITROGENOUS ORGANIC MATERIAL
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Du Pont de Nemours & Co., E. I., Wilmington, Del.
Huber & Company, New York City.
International Agricultural Corp., New York City.
Smith-Rowland Co., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

NOZZLES—Spray
Monarch Mfg. Works, Inc., Philadelphia, Pa.

PACKING—For Acid Towers
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

PANS AND POTS
Stedman's Foundry and Mach. Works, Aurora, Ind.

PHOSPHATE MINING PLANTS
Chemical Construction Corp., New York City.

PHOSPHATE ROCK
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Charleston Mining Co., Inc., Richmond, Va.
Huber & Company, New York City.
International Agricultural Corp., New York City.
Jett, Joseph C., Norfolk, Va.
Ruhm, H. D., Mount Pleasant, Tenn.
Schmaltz, Jos. H., Chicago, Ill.
Southern Phosphate Corp., Baltimore, Md.
Taylor, Henry L., Wilmington, Del.
Wellmann, William E., Baltimore, Md.

PIPES—Chemical Stoneware
Chemical Construction Corp., New York City.

PIPES—Wooden
Stedman's Foundry and Mach. Works, Aurora, Ind.

PLANT CONSTRUCTION—Fertilizer and Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

POTASH SALTS—Dealers and Brokers
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Agricultural Corp., New York City.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Synthetic Nitrogen Products Co., New York City.
Taylor, Henry L., Wilmington, Del.
Wellmann, William E., Baltimore, Md.

POTASH SALTS—Manufacturers and Importers
American Potash and Chem. Corp., New York City.
Potash Co. of America, Baltimore, Md.
United States Potash Co., New York City.

PULLEYS AND HANGERS
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

PUMPS—Acid-Resisting
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

PYRITES—Brokers
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Jett, Joseph C., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

QUARTZ
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

RINGS—Sulphuric Acid Tower
Chemical Construction Corp., New York City.

A Classified Index to Advertisers in "The American Fertilizer"

BUYERS' GUIDE

For an Alphabetical List of all the Advertisers, see page 33

ROUGH AMMONIATES
Bradley & Baker, New York City.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

SCALES—Including Automatic Bagging
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SCRAPERS—Drag
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.

SCREENS
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SEPARATORS—Air
Sackett & Sons Co., The A. J., Baltimore, Md.

SEPARATORS—Including Vibrating
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

SEPARATORS—Magnetic
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SHAFTING
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SHOVELS—Power
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Link-Belt Speeder Corp., Chicago, Ill. and Cedar Rapids, Iowa.
Sackett & Sons Co., The A. J., Baltimore, Md.

SPRAYS—Acid Chambers
Monarch Mfg. Works, Inc., Philadelphia, Pa.

SPROCKET WHEELS (See Chains and Sprockets)

STACKS
Sackett & Sons Co., The A. J., Baltimore, Md.

SULPHATE OF AMMONIA
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Company, The, New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Hydrocarbon Products Co., New York City.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Snythetic Nitrogen Products Co., New York City.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

SULPHUR
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Freeport Sulphur Co., New York City.
Texas Gulf Sulphur Co., New York City.

SULPHURIC ACID
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.

SULPHURIC ACID—Continued
Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
U. S. Phosphoric Products Corp., New York City.
Wellmann, William E., Baltimore, Md.

SUPERPHOSPHATE
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Agricultural Corp., New York City.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, N. C.
U. S. Phosphoric Products Corp., New York City.
Wellmann, William E., Baltimore, Md.

SUPERPHOSPHATE—Concentrated
Armour Fertilizer Works, Atlanta, Ga.
International Agricultural Corp., New York City.
U. S. Phosphoric Products Corp., New York City.

SYPHONS—For Acid
Monarch Mfg. Works, Inc., Philadelphia, Pa.

TALLOW AND GREASE
American Agricultural Chemical Co., New York City.

TANKAGE
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
International Agricultural Corp., New York City.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Smith-Rowland Co., Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

TANKAGE—Garbage
Huber & Company, New York City.

TANKS
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons Co., The A. J., Baltimore, Md.

TILE—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

TOWERS—Acid and Absorption
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

UNLOADERS—Car and Boat
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

UREA
Du Pont de Nemours & Co., E. I., Wilmington, Del.
Snythetic Nitrogen Products Co., New York City.

UREA-AMMONIA LIQUOR
Du Pont de Nemours & Co., E. I., Wilmington, Del.

VALVES—Acid-Resisting
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

WHEELBARROWS (See Carts)

ZINC SULPHATE
Tennessee Corporation, Atlanta, Ga.

ALPHABETICAL LIST OF ADVERTISERS

For Classified Index, see pages 28 to 32, inclusive


P. C. A. Red Muriate is ideal in plant operation—Uniform in color—Uniform in analysis —Uniform in grain size.
Muriate of Potash 50% and 60%
Manure Salts
P.C.A.
RED MURIATE
POTASH COMPANY
of America
GENERAL SALES OFFICE
MERCANTILE TRUST BUILDING
BALTIMORE, MARYLAND
SOUTHERN SALES OFFICE MORTGAGE GUARANTEE BUILDING ATLANTA, GEORGIA